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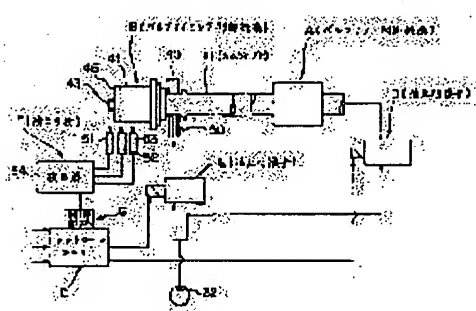
(54) TAPPET VALVE SYSTEM OF INTERNAL COMBUSTION ENGINE



(57)Abstract:
PURPOSE: To stabilize the extent of drivability by preventing any torque shock, with the sudden variation of intake air charging efficiency, from occurring.
CONSTITUTION: A tappet valve system in this internal combustion engine is provided with a valve lift control mechanism A and a valve timing control mechanism B, controlling both these mechanisms A, B by a control unit C according to an engine driving state. Also it is provided with three electromagnetic pickups 51-53 or a detecting means F detecting a relative turning phase difference between a camshaft 11 and a sprocket 41 and a detector 54, while there is provided a control circuit G which controls a changeover of high-low sides of the valve lift control mechanism A on the basis of an output signal out of the detecting means F, thus intake air charging efficiency is gently varied.

CLAIMS

[Claim(s)]
[Claim 1] The controller which detects current engine operational status from an engine rotational frequency and a load at least, The valve-lift controlling mechanism which switches the valve-lift property of an intake/exhaust valve to a low-speed or high-speed side based on the output signal from this controller, It is the moving valve mechanism

equipped with the valve timing control unit which changes the relative rotation phase of a crankshaft and a cam shaft based on the output signal from said controller, and switches the closing motion stage property of an intake/exhaust valve to an advancing-side or delay side. The moving valve mechanism of the internal combustion engine characterized by preparing the control circuit which controls the switch by the side of the low speed of said valve-lift controlling mechanism, and a high speed based on the output signal from this detection means while establishing a detection means to detect the relative rotation phase contrast of said crankshaft and cam shaft.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the moving valve mechanism of the internal combustion engine which switched the valve-lift property, carrying out adjustable control of the valve timing.
[0002]
[Description of the Prior Art] If it is in an automobile engine, it is the purpose which is compatible from the former in the improvement in an output at the time of the torque at the time of low medium-speed operation, and high-speed operation, the lift property of an inlet valve or an exhaust valve is changed according to operational status, and the thing equipped with the valve-lift controlling mechanism which controls the timing or the amount of pumping of pumping by this is known (for example, reference, such as JP,62-121811,A).
[0003] The rocker arm for high speeds which this adjoins one side of the rocker arm for low speeds to which that rocking tip contacts an inlet valve, and this rocker arm for low speeds, and does not have a contact part with an inlet valve is supported by the common rocker shaft rockable. Moreover, the cam for high speeds which has the profile to which the cam for low speeds becomes a rocker arm for low speeds, and a valve-opening include angle or the amount of valve lifts becomes large rather than the cam for low speeds at the rocker arm for high speeds is in slide contact, respectively.
[0004] Furthermore, the connection means for switching which consists of a plunger of which connection or connection is canceled to one, a guide hole, etc. is prepared in each rocker arm in this each rocker arm.
[0005] And according to the present engine operational status, a connection means for switching is controlled based on the output signal from a controller, as shown in drawing 10 at the time of low rotation of an engine, connection of each rocker arm is canceled and it considers as the valve-lift property by the side of a low speed, and at the time of high rotation, each rocker arm is connected with one and is alternatively

switched to the valve-lift property by the side of a high speed. While making small the amount of valve lifts of an inlet valve, controlling a closed stage to become earlier than a bottom dead point, making small mechanical losses, such as an engine's pumping loss and friction, as much as possible and raising fuel consumption etc. by this at the time of low rotation, at the time of high rotation, by bringing a valve-opening stage forward greatly [amount / of valve lifts / of an inlet valve], the charging efficiency of inhalation of air is raised and sufficient output is secured.

[0006]

[Problem(s) to be Solved by the Invention] However, in the valve-lift property by the side of a low speed, and the valve-lift property by the side of a high speed, if the internal combustion engine having ** et al. and said valve-lift controlling mechanism has, since each inhalation-of-air charging efficiency is remarkably different, it occurs at the time of a switch of each of this valve-lift property, change, i.e., the big torque shock, of a big output. Consequently, destabilization of operation is caused.

[0007]

[Means for Solving the Problem] This invention is what was thought out in view of the trouble of the internal combustion engine having said valve-lift controlling mechanism. It has the valve timing controlling mechanism which changes the relative rotation phase of a crankshaft and a cam shaft, and switches closing motion stages other than a valve-lift controlling mechanism, such as an inlet valve, to an advancing-side or delay side. While establishing a detection means to detect the relative rotation phase contrast of a crankshaft and a cam shaft, it is characterized by preparing the control circuit which controls the switch by the side of the low speed of said valve-lift controlling mechanism, and a high speed based on the output signal from this detection means.

[0008]

[Function] In case an engine shifts to inside and the load region in a high speed from a low-speed low load region, a controller changes the relative rotation phase of a crankshaft and a cam shaft, using the so-called time lag to which the switch control rate of valve timing becomes slow a little and this invention switches the closed stage of an inlet valve from the advancing side to a delay side rather than the switch control rate of a valve lift, a detection means detects this relative rotation phase contrast, and it outputs it to a control circuit, and switches a valve-lift property.

[0009] That is, the closed stage of an inlet valve is in the advancing side in the valve-lift property by the side of a low speed, and although an inhalation-of-air charging efficiency is very low, once it controls valve timing by the valve timing controlling mechanism to a delay side here, an inhalation-of-air charging efficiency will rise. And since valve timing is in a delay side greatly when it switches to the valve-lift property by the side of [a low-speed side to] a high speed after switching valve timing to a delay side, change of an inhalation-of-air charging efficiency becomes small. Furthermore, if that valve timing is switched to the advancing side from this condition, an inhalation-

of-air charging efficiency will rise to max conjointly with a high-speed side valve-lift property. Thus, it becomes possible by performing a switch of a valve lift using the time lag at the time of switch control of valve timing to make it change gradually, without changing an inhalation-of-air charging efficiency rapidly.

[0010]

[Example] Hereafter, the example of this invention is explained in full detail based on a drawing. In addition, this example shows what was applied to the internal combustion engine having two valves (any of an inlet valve and an exhaust valve are sufficient, and the thing of illustration is taken as an inlet valve) which have the same function about one gas column.

[0011] Namely, the valve-lift controlling mechanism by which drawing 1 is the schematic diagram showing the whole configuration of this example, and A was attached to the cam shaft 11, The valve timing controlling mechanism by which B was prepared in the end section of a cam shaft 11, The controller slack control unit to which C operates these both A and B according to engine operational status through each oil pressure change-over valve D and E, F is a detection means to detect the actuated position of the valve timing controlling mechanism B, i.e., the relative rotation location of the sprocket 41 and cam shaft 11 which are mentioned later, and to output the detecting signal to the control circuit G in a control unit C.

[0012] Said valve-lift controlling mechanism A is constituted as shown in drawing 2 - drawing 5 R> 5. Namely, the single Maine rocker arm 1 corresponding to two inlet valves 3 and 3 is formed in each gas column, and while end face section 1a is supported by the cylinder head free [rocking] through the Maine rocker shaft 4 common to each gas column, point 1b is in contact [as for this Maine rocker arm 1] with the stem crowning of inlet valves 3 and 3. Moreover, while this Maine rocker arm 1 presents the shape of a flat-surface abbreviation rectangle and notching formation of the rectangle-like opening 5 is carried out at the longitudinal direction of one flank, notching formation of the rectangle hole 6 of the shape of a big abbreviation rectangle of area is carried out rather than said opening 5 also at the longitudinal direction of other flanks, and the notching aperture 7 which makes this rectangle hole 6 face outside is formed in the front end side of paries-lateralis-orbitae 1C of this rectangle hole 6. And as shown in said opening 5 also at drawing 5 , while the roller 10 is formed in the shaft 8 free [rotation] through the needle bearing 9, the subrocker arm 2 is arranged in the rectangle hole 6. Moreover, the cam 12 for low speeds which it has in the cam shaft 11 which carries out synchronous rotation with the crankshaft outside drawing is ****(ing) said roller 10.

[0013] As shown also in drawing 4 , while the end face is supported free [rocking] relatively [rocker arm / 2 / Maine] through the subrocker shaft 13, said subrocker arm 2 It does not have the part which contacts an inlet valve 3, but the cam follower section 15 which ****s for the cam 12 for low speeds and the installed cam 14 for high speeds

projects at the tip in the shape of radii, and is formed in it. To the down side The lost motion spring 16 which forces the cam follower section 15 on the cam 14 for high speeds is infixed. Moreover, while having inserted said subrocker shaft 13 in insertion hole 2a formed in the interior of the end face of the subrocker arm 2 free [sliding], press fit immobilization of it is carried out in the holes 17 and 17 for press fit where the both ends 13a and 13b were drilled in the six rectangle hole opposite location of end face section 1a.

[0014] Moreover, the crevice 18 of the shape of a cylinder which is located directly under the subrocker arm 2, and infixes the lost motion spring 16 in the Maine rocker arm 1 as shown also in drawing 4 is really formed. The lower limit of the coiled form lost motion spring 16 sits down to bottom plate 18a of a crevice 18, and the upper limit is pressing the follower section 20 really formed in the subrocker arm 2 through the retainer 19 which fits into a crevice 18 free [sliding].

[0015] Moreover, it is constituted, as it is the connection means for switching connected and canceled suitably 21 in drawing and this connection means for switching 21 shows the Maine rocker arm 1 and the subrocker arm 2 to drawing 2 and drawing 3 . That is, in the flank of the roller 10 of the Maine rocker arm 1, while the closed-end cylinder-like 1st guide hole 23 is formed crosswise and the short length shape [of a cylinder] piston 22 is held free [sliding] to this interior, the oil sac 24 is formed behind this piston 22. on the other hand -- the subrocker arm 1 -- a 1st guide hole 23 and same axle top -- and the 2nd guide hole 25 of the diameter of the same is formed, and the plunger 27 with which an end energizes said piston 22 in the oil sac 24 direction through the return spring 26 supported by the retainer 28 to this 2nd guide hole 25 is contained.

[0016] And when a piston 22 fits in over the 1st and 2nd guide holes 22 and 25 with the actuation oil pressure led to an oil sac 24, the Maine rocker arm 1 and the subrocker arm 2 are connected with one. On the other hand, when actuation oil pressure is not introduced in an oil sac 24, connection of both the rocker arms 1 and 2 is canceled in the condition of the piston 22 having been pushed on the oil sac 24 side through the plunger 27 according to the spring force of a return spring 26, and having fitted in the 1st guide hole 23.

[0017] Moreover, the hydraulic circuit 29 which leads actuation oil pressure to said oil sac 24 consists of an oil gallery 30 formed in the internal shaft orientations of the Maine rocker shaft 4 as shown in drawing 2 , and an oil path 31 which opens an oil sac 24 and the oil gallery 30 for free passage through radial [of the Maine rocker shaft 4], and the interior of the Maine rocker arm 1.

[0018] The regurgitation oil pressure of an oil pump is led to the oil gallery 30 through said oil pressure change-over valve D at the time of high-speed predetermined operation. The solenoid valve of a 3 port 2 location mold is used, and, as for the oil pressure change-over valve D, actuation is controlled through the control circuit G of a control unit C. Fundamentally, this control unit outputs this detecting signal to the oil

pressure change-over valve D while it inputs an engine rotation signal, a cooling water temperature signal, the temperature signal of a lubricating oil, the charge pressure force signal of the inhalation of air by the supercharger, the opening signal of a throttle valve, etc. and detects current engine operational status based on these detection values.

[0019] The cam 14 for high speeds which adjoins said cam 12 for low speeds and this is really formed in the respectively common cam shaft 11, and is formed in a configuration (the analog from which magnitude differs is also included) which is different so that the valve-lift property demanded at the time of low rotation of an engine and high rotation may be satisfied. That is, the cam 14 for high speeds has the profile which enlarges either [at least] the amount of valve lifts, or a valve-opening period compared with the cam 12 for low speeds. Here, the amount of valve lifts and the valve-opening period are both enlarged.

[0020] therefore -- according to this valve-lift controlling mechanism A -- the time of engine low r.p.m. operation -- the Maine rocker arm 1 -- the profile of the cam 12 for low speeds -- following -- rocking -- the closing motion drive of each inlet valve 3 -- it carries out. Although the subrocker arm 2 is rocked by the cam 14 for high speeds at this time, each piston 22 and a plunger 27 are settled in each guide holes 23 and 25 according to the energization force of a return spring 26, respectively, and a motion of the Maine rocker arm 1 is not barred.

[0021] On the other hand, at the time of high-speed operation of an engine, if the actuation oil pressure fed from the oil pump 32 is led to an oil sac 24 through the oil gallery 30 and the oil path 31, each piston 22 and a plunger 27 will be resisted and moved to a return spring 26, and a piston 22 will fit in over each guide holes 23 and 25. By this, both the rocker arms 1 and 2 are united, and rock. Here, since both the cams 14 for high speeds are formed as compared with the cam 12 for low speeds so that the aperture include angle and the amount of lifts of a valve may serve as size, the roller 10 of the Maine rocker arm 1 loses touch with the cam 12 for low speeds at the time of rocking united with the subrocker arm 2, according to the profile of the cam 14 for high speeds, the closing motion drive of each inlet valve 3 is carried out, and both the aperture include angles and amounts of lifts of a valve become large.

[0022] On the other hand, if engine operational status shifts to a low rotation region again from a high rotation region, the oil pressure led to an oil sac 24 by actuation of the oil pressure change-over valve D will fall, a piston 22 and a plunger 27 will move to the original location according to the elastic stability of a return spring 26, and constraint of the Maine rocker arm 1 will be canceled.

[0023] Thereby, as shown in Fig. 7, the valve-lift property X1 based on the profile of the cam 12 for low speeds and the valve-lift property X2 based on the profile of the cam 14 for high speeds are compounded, and improvement in fuel consumption and improvement in the output torque in a high rotation region can be aimed at in a low rotation region.

[0024] On the other hand, said valve timing controlling mechanism B is established between the cam shaft 11 supported to revolve by the cylinder head through the bracket 40 as shown in drawing 6 , and the sprocket 41 which driving force is delivered from a crankshaft, and the sleeve 42 is formed in front end section 11a of said cam shaft 11 with the mounting bolt 43. This sleeve 42 is supported for said sprocket 41 by flange 44 peripheral face of an edge, enabling free rotation while outer gear-tooth 42a is formed in the periphery.
[0025] While inner gear-tooth 45a is formed in the inner circumference of the tubed body 45 which inserted said sprocket 41 in the periphery of a sleeve 42, heel opening of this tubed body 45 is blockaded by the circular ring-like covering section 46. Moreover, between this tubed body 45 and sleeve 42, the tubed gearing 47 which can move to shaft orientations freely is infixed.
[0026] This tubed gearing 47 consists of the two gearings configuration sections approximately, and the inside-and-outside gear teeth 47a and 47b of ****** are formed in each inside-and-outside peripheral surface for both with which said outer gear-tooth 42a and inner gear-tooth 45a gear. Furthermore, while being ahead energized until the before lateral-tooth vehicle configuration section runs against the covering section 46 by the spring force of the compression spring 48 ****(ed) between the gearing configuration section on the backside, and a flange 44, this tubed gearing 47 The setback is carried out until the back lateral-tooth vehicle configuration section runs against a flange 44 with the oil pressure in the pressure room 49 formed between the covering section 46 and the before lateral-tooth vehicle configuration section.
[0027] ** - In said pressure room 49, the oil pressure from an oil pump 32 eliminates by said oil pressure change-over valve E through a hydraulic circuit 50. Said oil pressure change-over valve E consists of 3 port 2 location mold solenoid valves like the oil pressure change-over valve D of the valve-lift controlling mechanism A, and actuation is controlled by the output signal from a control unit C.
[0028] This control unit C is carrying out ON-OFF control of said oil pressure change-over valve E by using not only an engine's load but a rotational frequency as a control member.
[0029] Therefore, with the output signal from a control unit C, the oil pressure change-over valve E is turned on, and this valve timing controlling mechanism B specifically carries out Kaisei of the hydraulic circuit 50 in the time of an engine's idling, or a low-speed low load region. For this reason, as for the hydraulic oil fed from the oil pump 32, oil pressure is supplied to the pressure room 49 through a hydraulic circuit 50. Therefore, the tubed gearing 47 resists the spring force of a compression spring 48, is energized by the back location (the direction of drawing Nakamigi), and makes the relative rotation of the cam shaft 11 carry out to a sprocket 41 in the one side of a cam shaft 11, i.e., a hand of cut and this direction. Therefore, a cam shaft 11 controls the closed stage of inlet valves 3 and 3 by this relative rotation location to the advancing

side.
[0030] On the other hand, when it shifts to an inside load region, the oil pressure change-over valve E is turned off, and a hydraulic circuit 50 is blockaded. For this reason, while supply of hydraulic oil in the pressure room 49 is intercepted, the oil pressure in this pressure room 49 flows backwards a hydraulic circuit 50, and is discharged from the drain path of the oil pressure change-over valve E. Therefore, the tubed gearing 47 moves forward (illustration location) according to the spring force of a compression spring 48. A cam shaft 11 carries out relative rotation to a sprocket 41 at the other side, and controls the closed stage of inlet valves 3 and 3 by this to a delay side.
[0031] Furthermore, when it shifts to a heavy load region, the closed stage of inlet valves 3 and 3 is controlled by the same operation as said low-speed low load region to the advancing side.
[0032] and three electromagnetism by which a detection means F to detect the relative rotation phase contrast of said this cam shaft 11 and sprocket 41 was formed in said covering section 46 and tubed body 45 -- pickup 51, 52, and 53 -- this -- each -- electromagnetism -- it has the detector 54 which computes a rotation location by inputting the output signal from pickup 51-53. The 1st electromagnetism, it detects the rotation phase of a cam shaft 11, pickup 51 has detected the angle of rotation by the pulse signal which continued as shown in drawing 9 A, and as for pickup 52, this also detects the rotation phase of a cam shaft 11, and the 2nd electromagnetism, as shown in drawing 9 B, it is outputting the pulse signal for every cam-shaft rotation. Moreover, the 3rd electromagnetism, pickup 53 detects the rotation phase of a sprocket 41, and as shown in drawing 9 C, it is outputting the pulse signal for every sprocket rotation. therefore, said detector 54 can be set between [Z] said 2nd [the] and the pulse signal outputted from pickup 52 and 53 the 3rd electromagnetism, respectively -- the pulse number of pickup 51 is counted the 1st electromagnetism, both 11 and 41 relative rotation phase contrast is detected, and the signal is outputted to the control circuit G.
[0033] A control circuit G is based on these both 11 and 41 relative rotation phase contrast. In case said oil pressure change-over valve D is controlled and engine operational status shifts to inside, a high speed, and a heavy load region from an idling and a low-speed low load region Based on the relative-position detecting signal from said detector 54, a control circuit G carries out open actuation of the oil pressure change-over valve D, leads oil pressure to an oil sac 24 through oil gallery 30 grade as mentioned above, connects both the rocker arms 1 and 2 with one, and switches to a high-speed side.
[0034] Specifically, the valve-lift controlling mechanism A serves as a valve-lift property by the side of a low speed like the continuous line X1 of drawing 7 by the cam 12 for low speeds first in the time of an idling, and a low-speed low load region. At this time, since the closed stage of inlet valves 3 and 3 is a stage earlier enough than a bottom dead point, it is in the condition of having fallen sharply as an inhalation-of-air

charging efficiency showed according to a points of drawing 8 , and b points.
[0035] A cam shaft 11 carries out [into this valve-lift property] relative rotation to a sprocket 41 at one side as mentioned above according to the valve timing controlling mechanism B, and the closed stage of inlet valves 3 and 3 is controlled to a delay side. Therefore, a valve timing property is controlled like the broken line X2 of drawing 7 , and since the closed stage of inlet valves 3 and 3 is controlled at a delay side and comes just behind a bottom dead point, an inhalation-of-air charging efficiency becomes c points, and becomes higher enough than b points.
[0036] Furthermore, it is switched to the cam 14 for high speeds with the shift to an engine's inside and a high-speed heavy load region from this condition, and becomes a high-speed side valve-lift property like the broken line Y2 of drawing 7 R> 7. At this time, since valve timing will be in the condition by the side of delay, the stage which was fully behind [the bottom dead point] in the closed stage of inlet valves 3 and 3 comes, and the inhalation of air which flowed into the combustion chamber will be returned. For this reason, an inhalation-of-air charging efficiency becomes d points of drawing 8 , and rises more slightly than c points.
[0037] Next, since it is switched to the advancing side as valve timing shows the continuous line Y1 of drawing 7 in the state of this high-speed side valve lift, an inhalation-of-air charging efficiency becomes e points, and rises most.
[0038] Thus, in order to perform a switch of a valve-lift property according to the time of a switch of valve timing, the abrupt change of an inhalation-of-air charging efficiency is controlled, and it can consider as gradual rising characteristics. Consequently, a big torque shock is prevented and stabilization of operability can be attained.
[0039] Moreover, also when it shifts to a low-speed low load region from a high-speed heavy load region, control contrary to the above-mentioned is performed and a big torque shock is prevented.
[0040] This invention is not limited to the configuration of said example, and can change still more smoothly the thing to which it is also possible to consider the valve-lift controlling mechanism A, the valve timing controlling mechanism B, etc. as another configuration, for example, each controlling mechanisms A and B are made as for a switch of a multistage story or a stepless story, then said inhalation-of-air charging efficiency. Moreover, in this example, although what was applied to the inlet-valve side was shown, it is also possible to apply to both by the side of an exhaust valve or an inlet valve, and an exhaust valve.
[0041]
[Effect of the Invention] In order to perform switch control of the valve-lift property by the valve-lift controlling mechanism based on the output signal from a detection means at the time of switch control of valve timing by the above explanation according to this invention so that clearly, the abrupt change of an inhalation-of-air charging efficiency is prevented. Consequently, a torque shock is controlled effectively and stabilization of

operability can be attained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The whole block diagram showing one example of this invention.
[Drawing 2] The top view showing the valve-lift controlling mechanism of this example.
[Drawing 3] The H-H line sectional view of drawing 2 .
[Drawing 4] The I-I line sectional view of drawing 2 .
[Drawing 5] The J-J line sectional view of drawing 2 .
[Drawing 6] The sectional view showing the valve timing controlling mechanism of this example.
[Drawing 7] Drawing showing the valve-lift timing characteristics in this example.
[Drawing 8] Drawing showing the inhalation-of-air charging-efficiency property in this example.
[Drawing 9] this example -- each -- electromagnetism -- the wave form chart of pickup.
[Drawing 10] Drawing showing the valve-lift property by the conventional valve-lift controlling mechanism.
[Description of Notations]
A [-- An oil pressure change-over valve, F / -- A detection means, G / -- A control circuit, 11 / -- Cam shaft.] -- A valve-lift controlling mechanism, B -- A valve timing controlling mechanism, C -- A control unit, D-E

[Translation done.]